TOXECON™ Retrofit for Mercury and Multi-Pollutant Control

2006 Symposium on Western Fuels

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Denver, CO

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Clean Coal Power Initiative

- The CCPI was initiated in 2002 with a goal of accelerating commercial deployment of advanced technologies to ensure the United States has clean, reliable, and affordable electricity.
- CCPI is an industry/government cost-shared partnership to implement clean coal technology under the National Energy Policy.

TOXECON™ – 270 MW Demonstration

- **Presque Isle Power Plant, Marquette MI**
  - **Units 7-9**
  - **PRB Coal from Antelope and Spring Creek Mines**
- **$53.3M**
  - **$24.9M DOE**
  - **$28.5M We Energies**
- **90% Hg Control**
- **70% SO_2 Control***
- **30% NO_X Control***

*** Potential**

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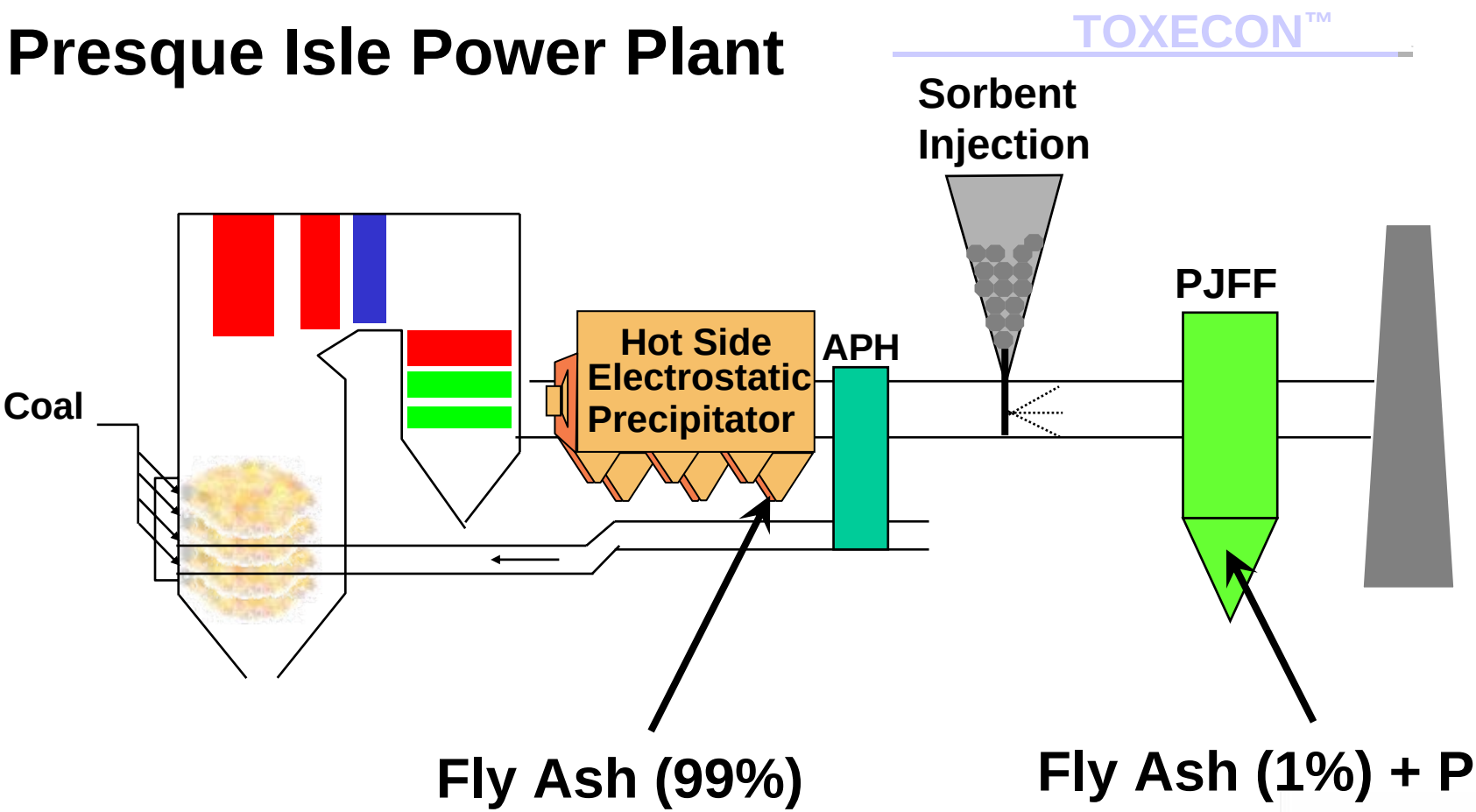
TOXECON™ Configuration

Presque Isle Power Plant



Project Status

- Pre-award (Feb ’03 to Feb ’04)
  - Project Management Plan
  - NEPA
- Design & Construction (Mar ’04-Jan ’06)
  - BOP
  - Equipment Procurement
  - Erection
  - Start-up
- Demonstration (Jan ’06-Mar ’09)
  - Mercury Optimization 2006
  - SO_2/NO_X Trim Control 2007
  - Ash Management 2008
  - Final Report 2009 (Jan – Mar)

PIPP Baghouse Design

- Pulse-Jet Fabric Filter
  - Supplied by Wheelabrator
  - On-line cleaning
  - Ability for off-line cleaning
- Air-To-Cloth Ratio
  - 5.5 ft/min (gross)
  - 1,080,000 acfm
- 10 Compartments
  - 660 bags/compartment
  - PPS fabric

ADA-ES ACI System at We Energies Presque Isle (270MW) TOXECON™

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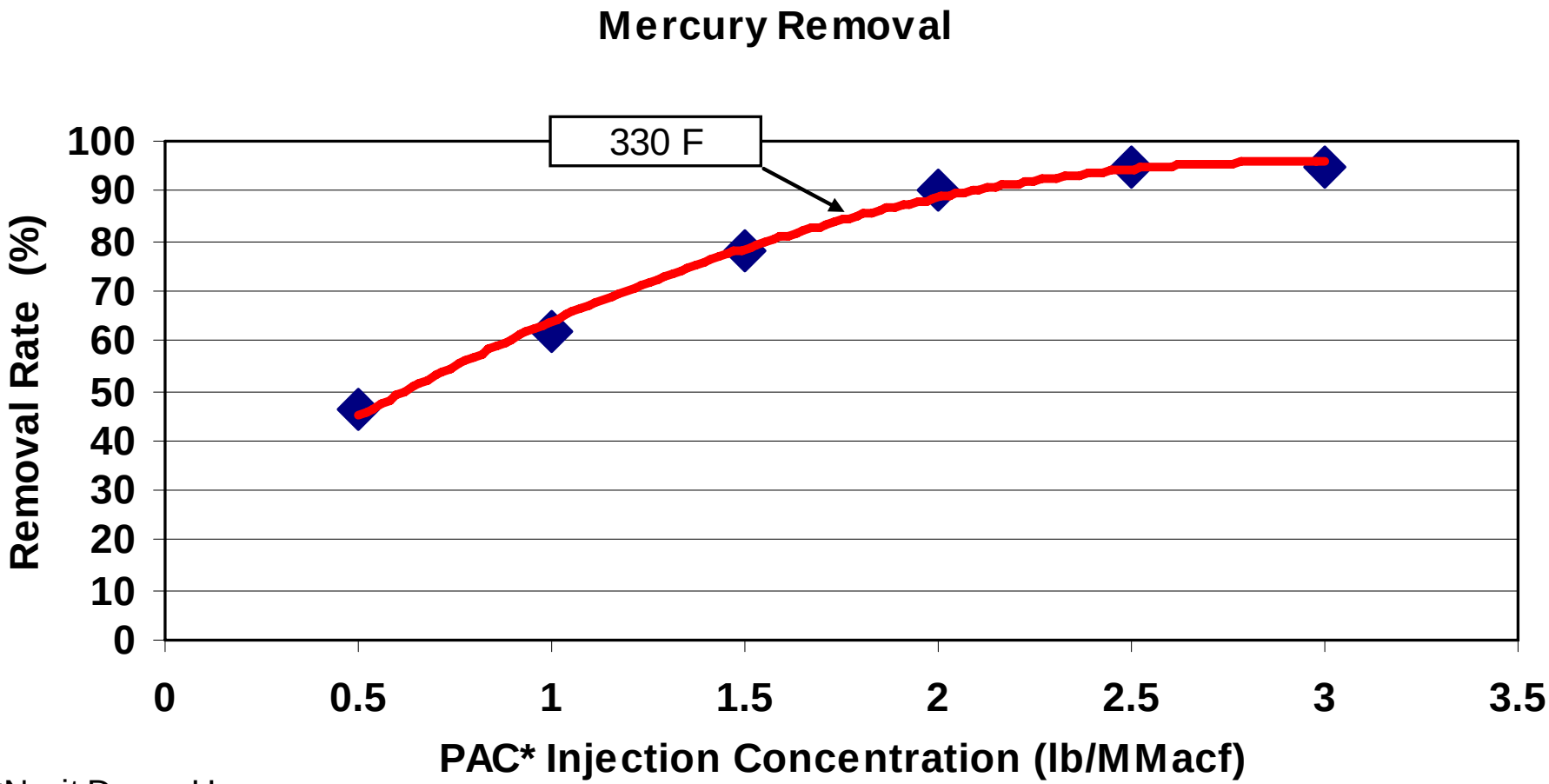
Thermo Electron Mercury CEMs

- Mercury Freedom System™
- Integrated with CEM DAS and Plant DCS

Schedule – Baseline and Parametric

Date	Activity
2/13/06 – 2/17/06	Baseline Testing • Two CEMs sampling from inlet and outlet of baghouse • Stack sampling (Ontario Hydro Method, Method 17 for particulate, Appendix K Sorbent Trap Method, Method 26A for halogens) • Ash and coal sampling
2/20/06 – 3/2/06	Round 1 Parametric Testing • Injection concentrations • CEMs sampling from inlet and outlet of baghouse • Baghouse ash and coal sampling
8/20/06 – 10/30/06	Round 2 Parametric Testing • Injection concentrations • Sorbents • CEMs sampling from inlet and outlet of baghouse • Baghouse ash and coal sampling

Preliminary Mercury Removal Results



*Norit Darco Hg

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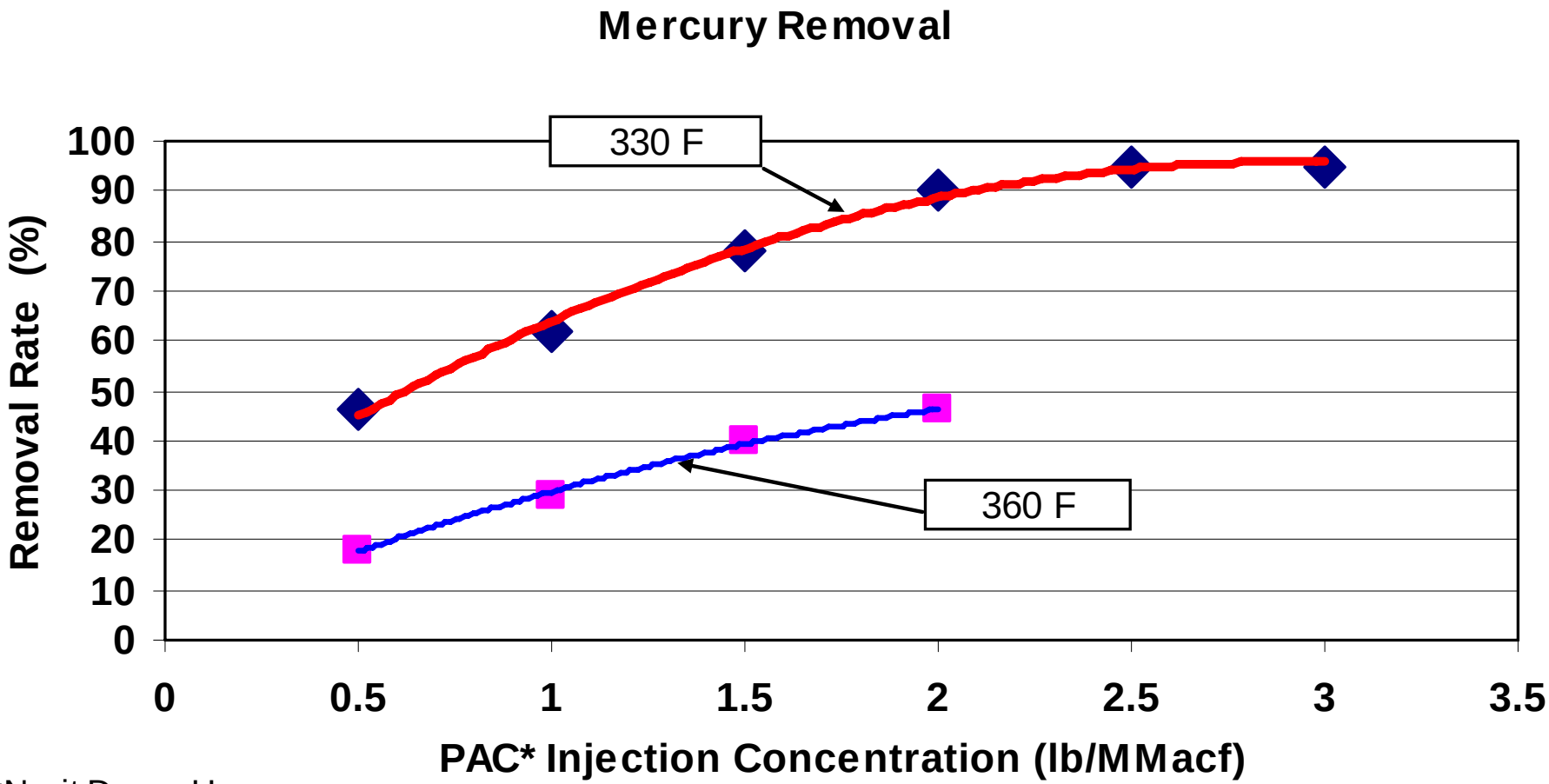

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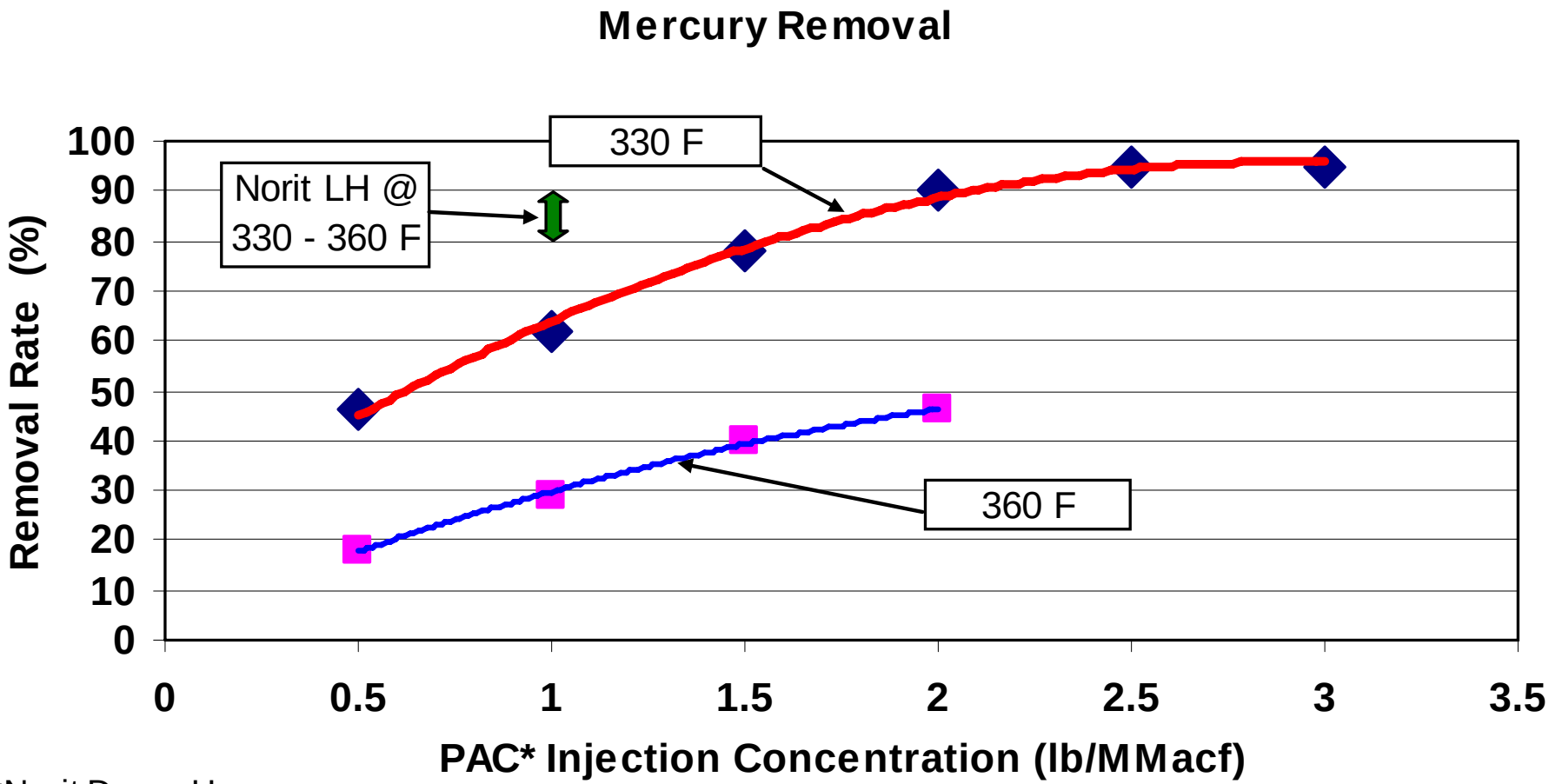

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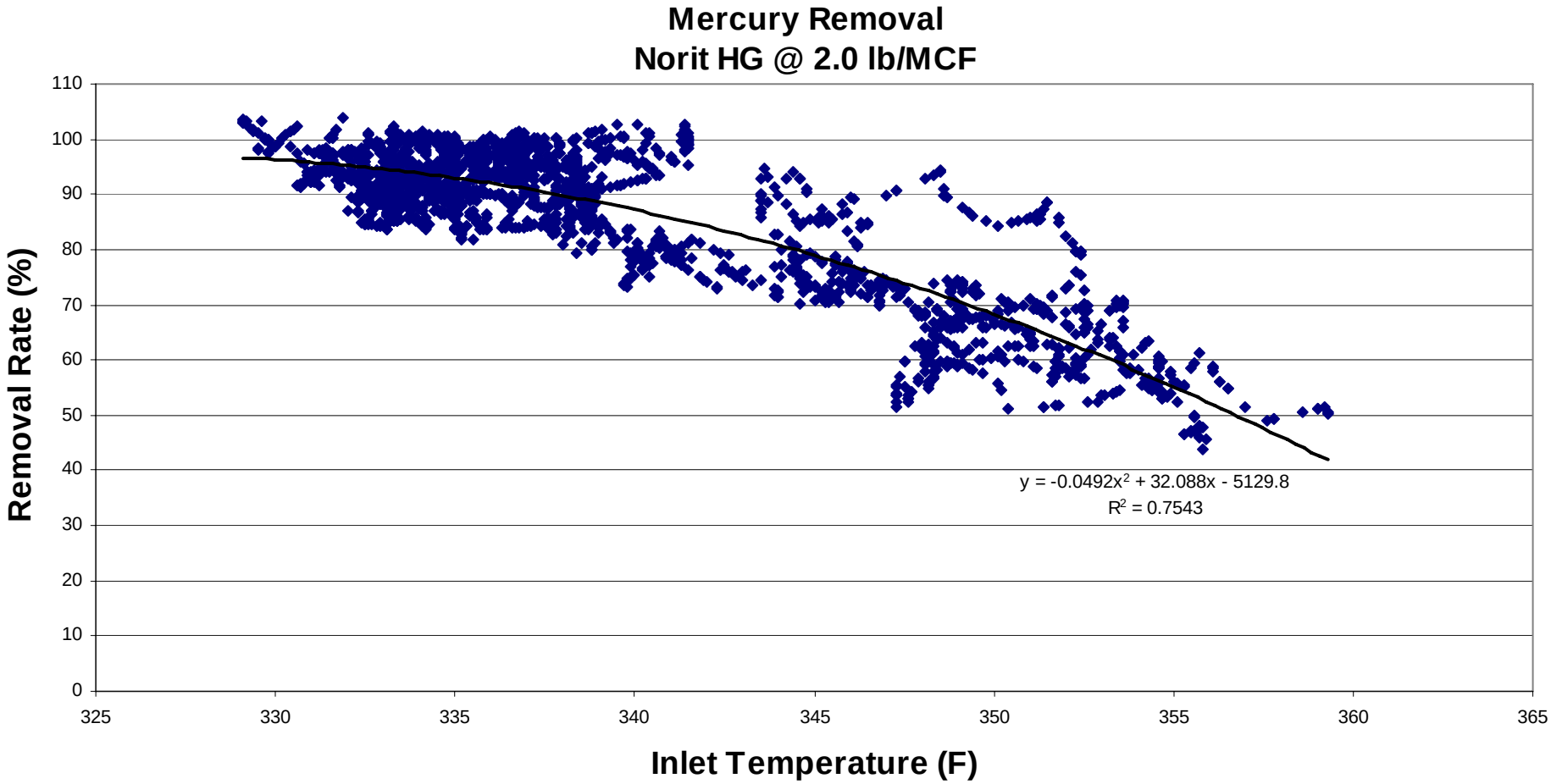
Mercury Removal Uncertainty



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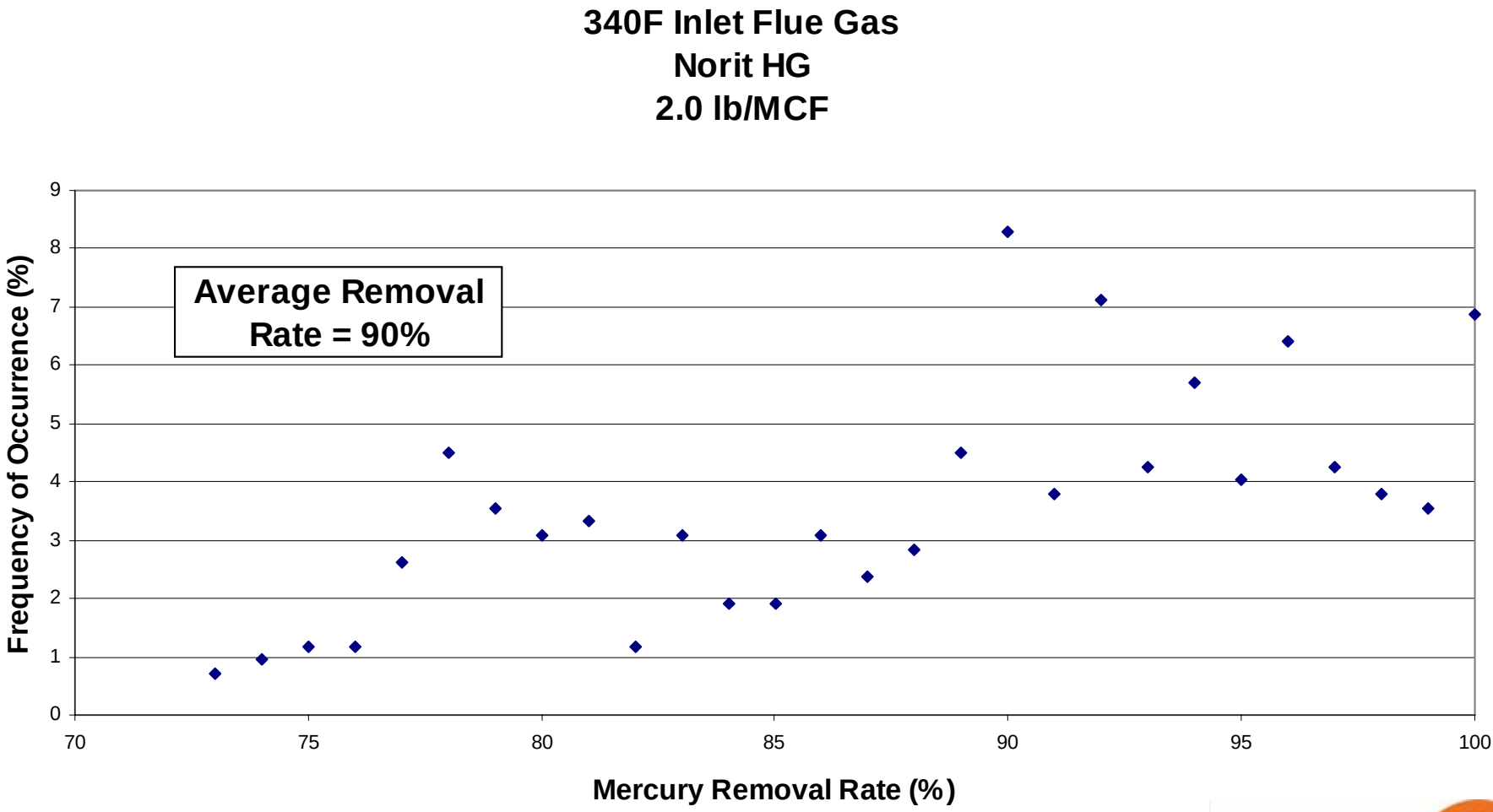


Balance of Plant Issues

- Smoldering PAC/ash in hoppers
- Bag cage separation
- Condensation at startup
- Ash silo unloading

Problem with Overheating PAC

- Hot burning embers found on 2/27
- By 3/2 all hoppers had embers
- Bypassed baghouse to investigate
- While extinguishing burning embers, unintentionally created additional flames in two compartments
  - 117 bags were failed in #4
  - 83 bags were failed in #3

Burned Bag

Potential Causes

Ignition temperature of material > 750°F

- Carry over of burning material
- External source such as welding or cutting
- Hopper heaters
  - Set for average temperature of 290°F
  - Testing showed heaters reached >400°F

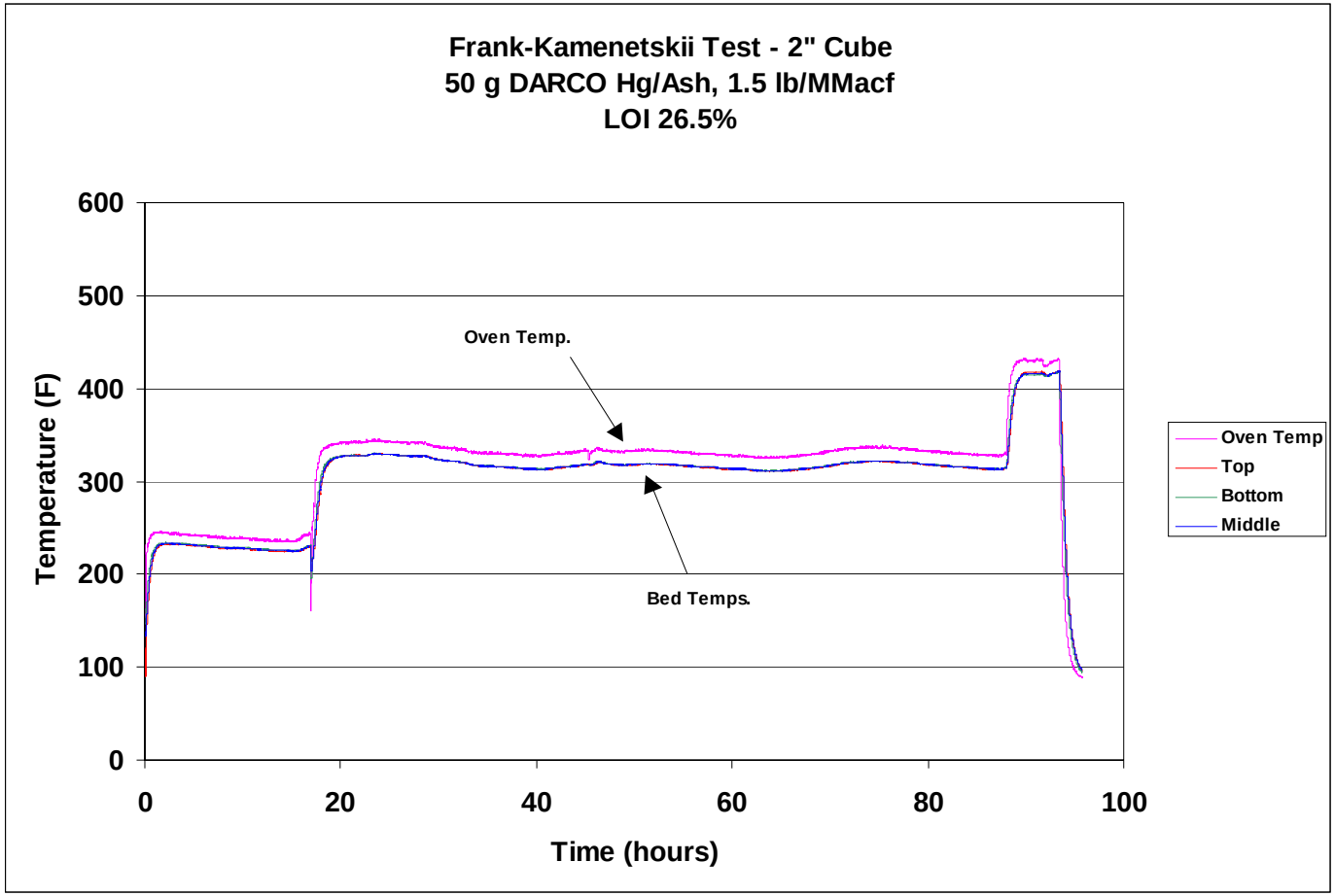
Proposed Mechanism for Overheating

- Frank-Kamenetskii Model predicts spontaneous combustion can occur in a material if an exothermic process (such as oxidation) produces heat faster than it can be dissipated.
- Spontaneous combustion typically occurs with a large mass of material (small surface to volume ratio).
- Activated carbon can exhibit “glowing combustion” which is caused by surface oxidation. This type of combustion doesn’t produce a flame.

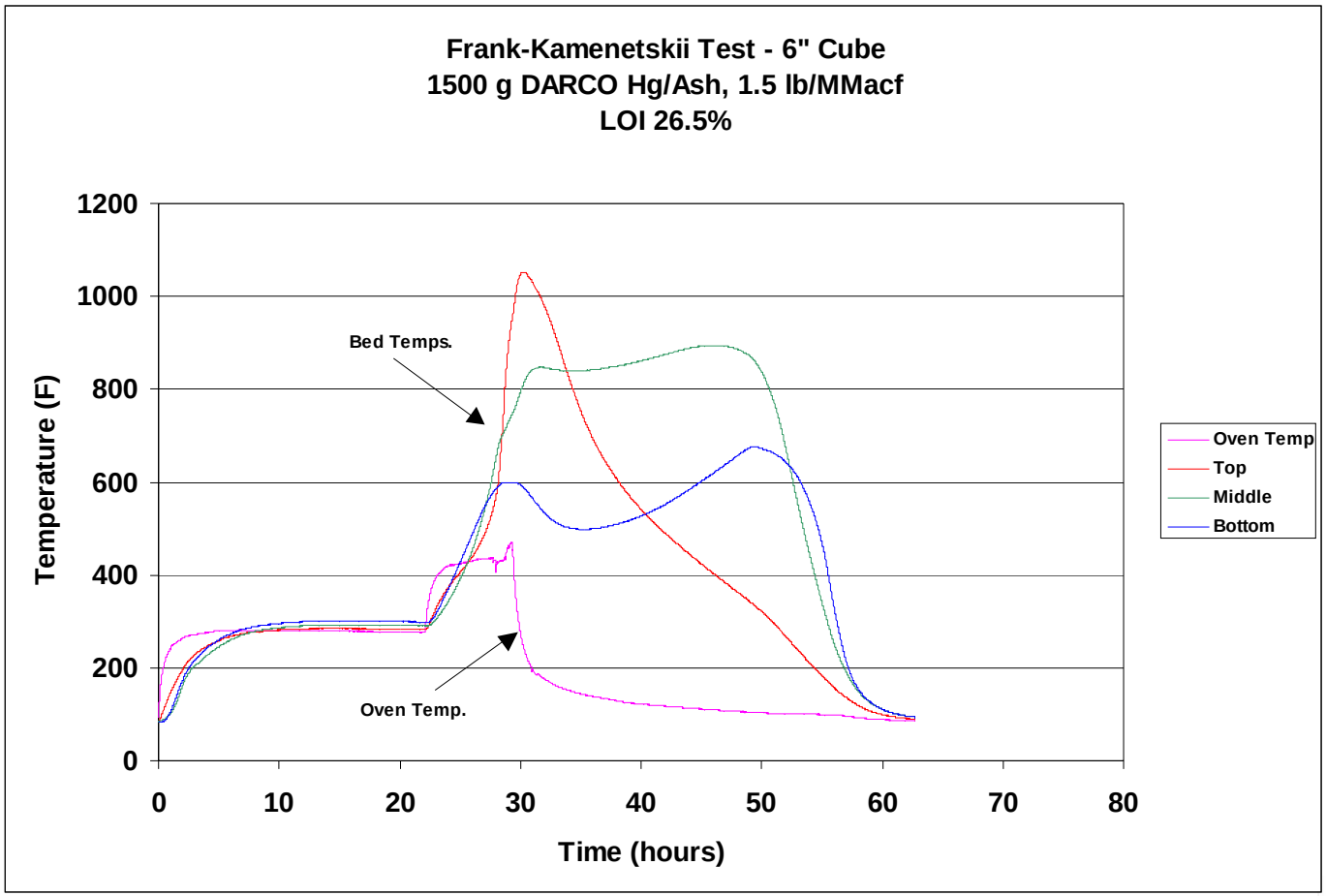
Laboratory Tests

- Placed different sized cubes filled with ash/PAC mixtures or PAC in an oven
- Monitored temperatures in bed of material

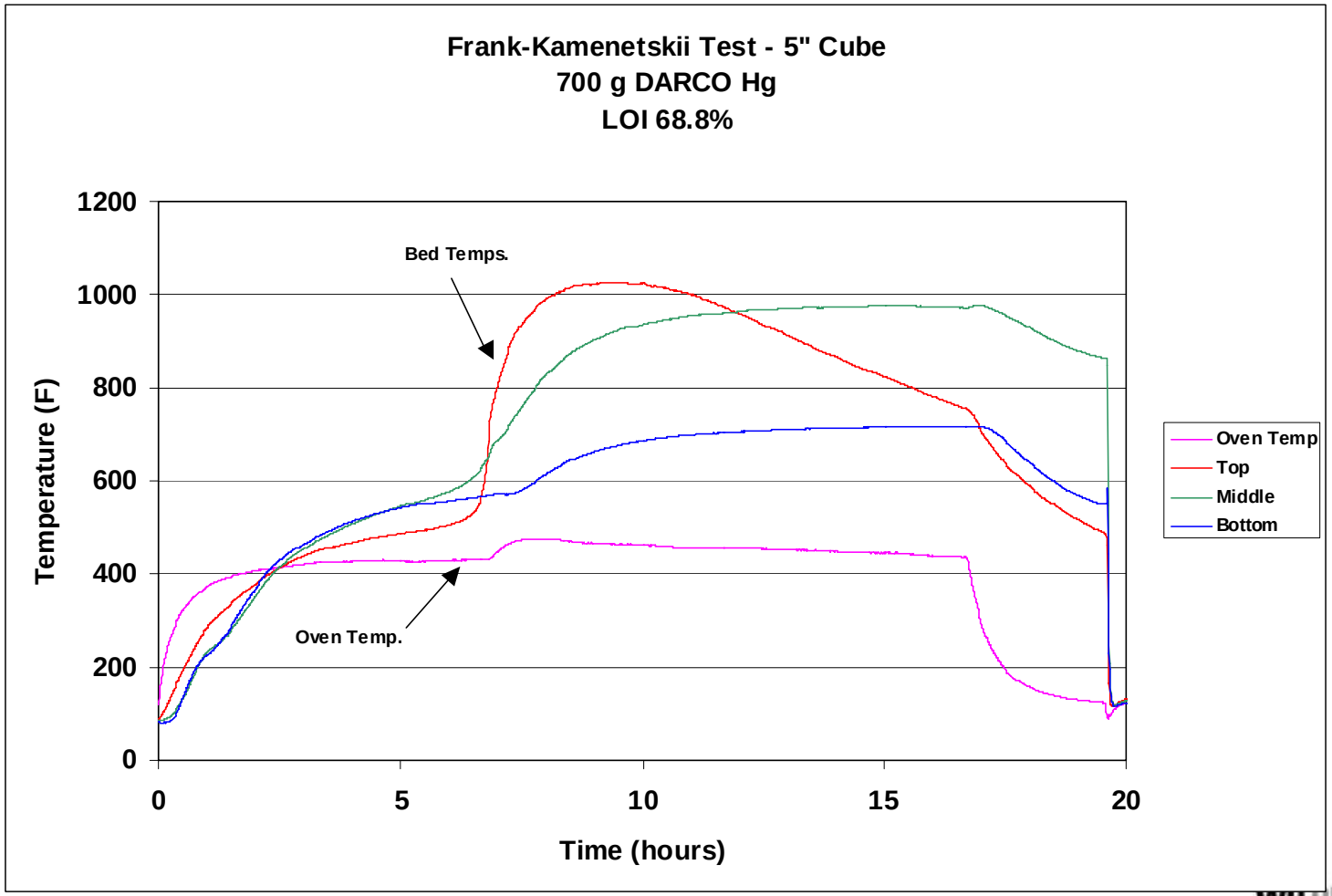
Temp. Profiles for 2” Cube PAC/Ash



Temp. Profiles for 6” Cube PAC/Ash



Temperature Profiles for 5” Cube of PAC



Burned Material in 6” Cube

Key Factors Affecting Auto Ignition

- Bed size
- Temperature surrounding bed
- LOI (% of carbon)
- Type of LOI (high vs. low surface area)
- Gas oxygen concentration

Bag Cage Separation

- 2 part cage with spring loaded collar
- Bottom half of cage was found to be laying in bottom of bag
- Large percentage of bags
- Two problems:
  - Faulty spot welds on lower retaining ring
  - Improper position of locking slider on upper cage

Condensation at Start-Up

- PI7 start-up through baghouse on 5/12/06.
- Both unit and baghouse were in “cold” condition.
- Followed vendor procedure but hopper heaters turned off.
- Water discovered in 6 hoppers 5/15/06.
- Baghouse bypassed for investigation.
- Appears to have been caused by improper warm-up of baghouse.
- Start-up with hopper heaters on.

Ash Silo Unloading

Addressing Ash Unloading Dusting

- With PAC added to the ash, silo unloading resulted in dust emissions
- Two problems were identified
  - Lack of flow control to the pin mixer
  - Inability of the pin mixer to provide a uniform, dustless product
- Valve in the silo was replaced
- Additional fluidizing air was added
- Water spray nozzles modified
- Additional design changes are being implemented

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What We Learned So Far

- Carbon injection effectively removes mercury
- Standard activated carbon is sensitive to temperature at low injection concentrations
- PAC/ash mixture can ignite when sufficient quantity is in hopper at temperatures above 350 °F
- PAC that has begun combusting will continue to burn with even very small amounts of oxygen
- PAC/ash mixture is “sticky” and hoppers tend to “rat-hole”
- Normal ash unloading equipment is not effective when handling PAC/ash mixtures

Design Recommendations

- Minimize PAC/ash storage in baghouse hoppers
  - Evacuate hoppers often
  - Prevent material build-up
- Control hopper temperatures
  - Eliminate or minimize use of hopper heaters
  - Controls should provide narrow band
- Install additional thermocouples or CO monitor for early detection

Conclusions

- CCPI demonstrations provide key support for the commercialization of new technologies
- Preliminary full-scale testing essential for establishing design basis and reducing risk
- First commercial mercury control system is now operational
  - Still some significant issues to resolve
  - The industry is closely watching this project


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